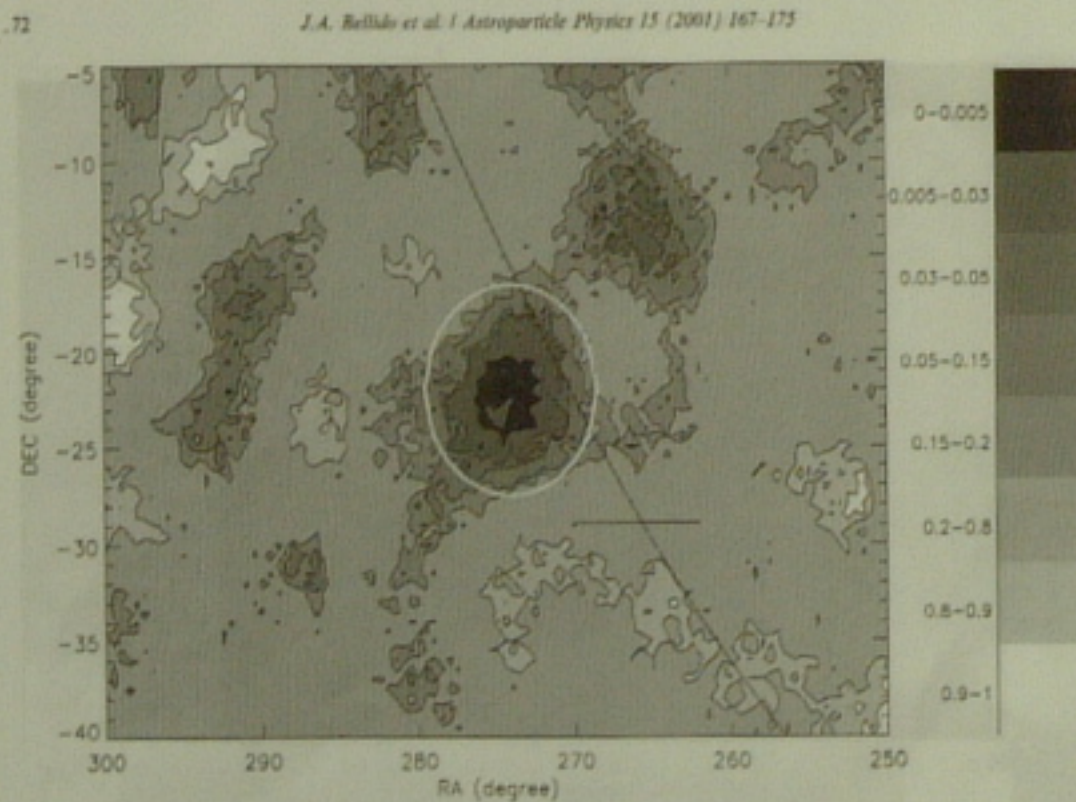


Astronomical Objects in the Direction of a Possible Southern EeV Cosmic Ray Source

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There is apparently an excess of cosmic ray events from some southern hemisphere directions in the energy range roughly 1-3 EeV. This observation was made by the AGASA group (Hayashida et al. 1999) and confirmed by examining data from the SUGAR array (Bellido et al. 2001).



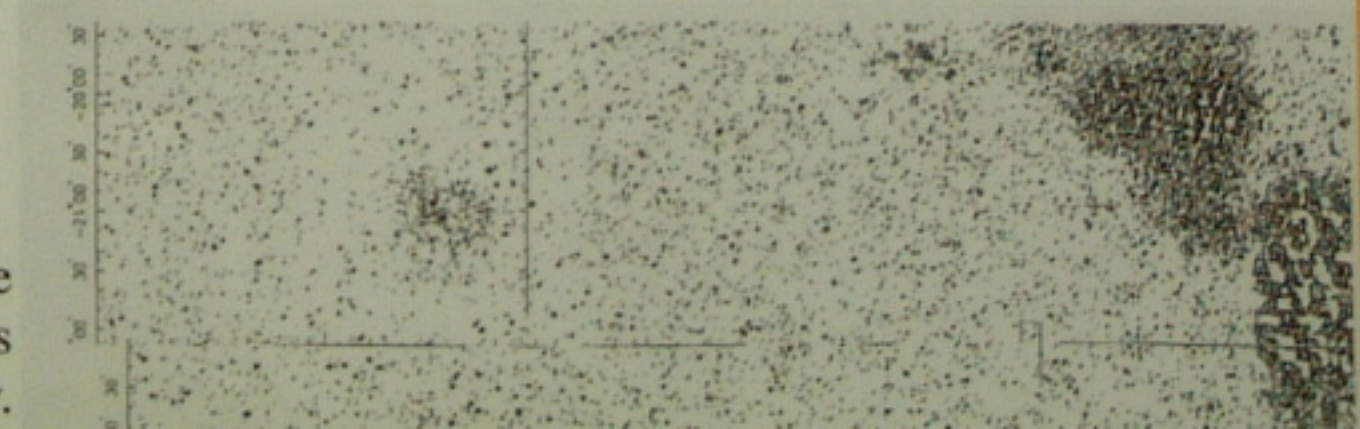
The former data showed a broad southern excess towards the galactic centre region and the latter showed a concentration of excess close to (but not coincident with) the galactic centre. Whilst these data appear mutually supportive, at this stage, neither is at a significance level which is completely secure.

The SUGAR data identifies a source region centred on RA $18^{\text{h}} 18^{\text{m}}$, dec -22° (J2000 coordinates) with a central spread of about 4° (figure 1). This region is $\sim 10^{\circ}$ from the galactic centre and to the south of the galactic plane. The AGASA spectral data suggest that the beam may contain a significant neutron component from a distance comparable with that of the galactic centre. We have examined the SUGAR region for any unusual or potential high energy sources.

Figure 1: Significance map of SUGAR data ($10^{17.9} - 10^{18.5}$ eV) close to the galactic centre

Figure 2 shows a 1420MHz (NVSS) map of the region, centred approximately on the source direction.

The galactic plane is prominent in the north-east and four apparent supernova remnants are visible. The most prominent of these is 1814-24 (Dickel and Milne 1976), also known as G7.7-3.7 (Dubner et al. 1996). Diffuse emission fills this remnant and it has a mean radio polarisation of about 10% of the total intensity.



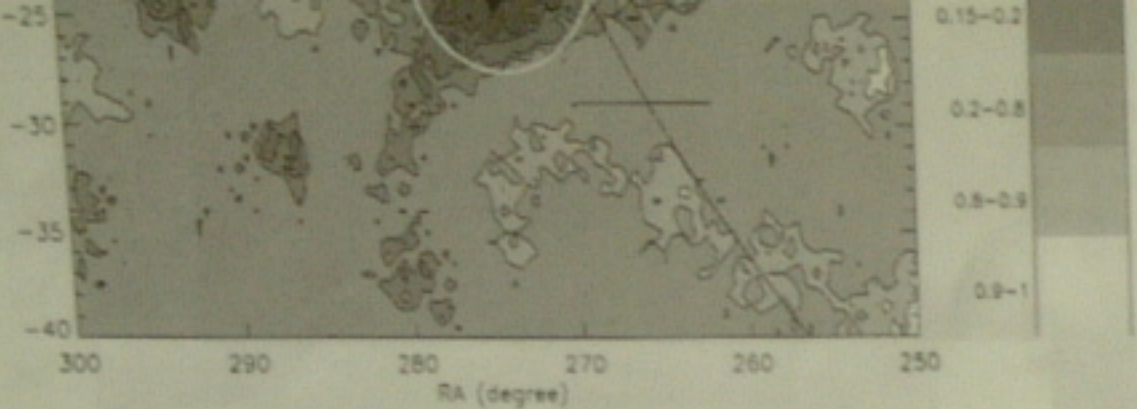


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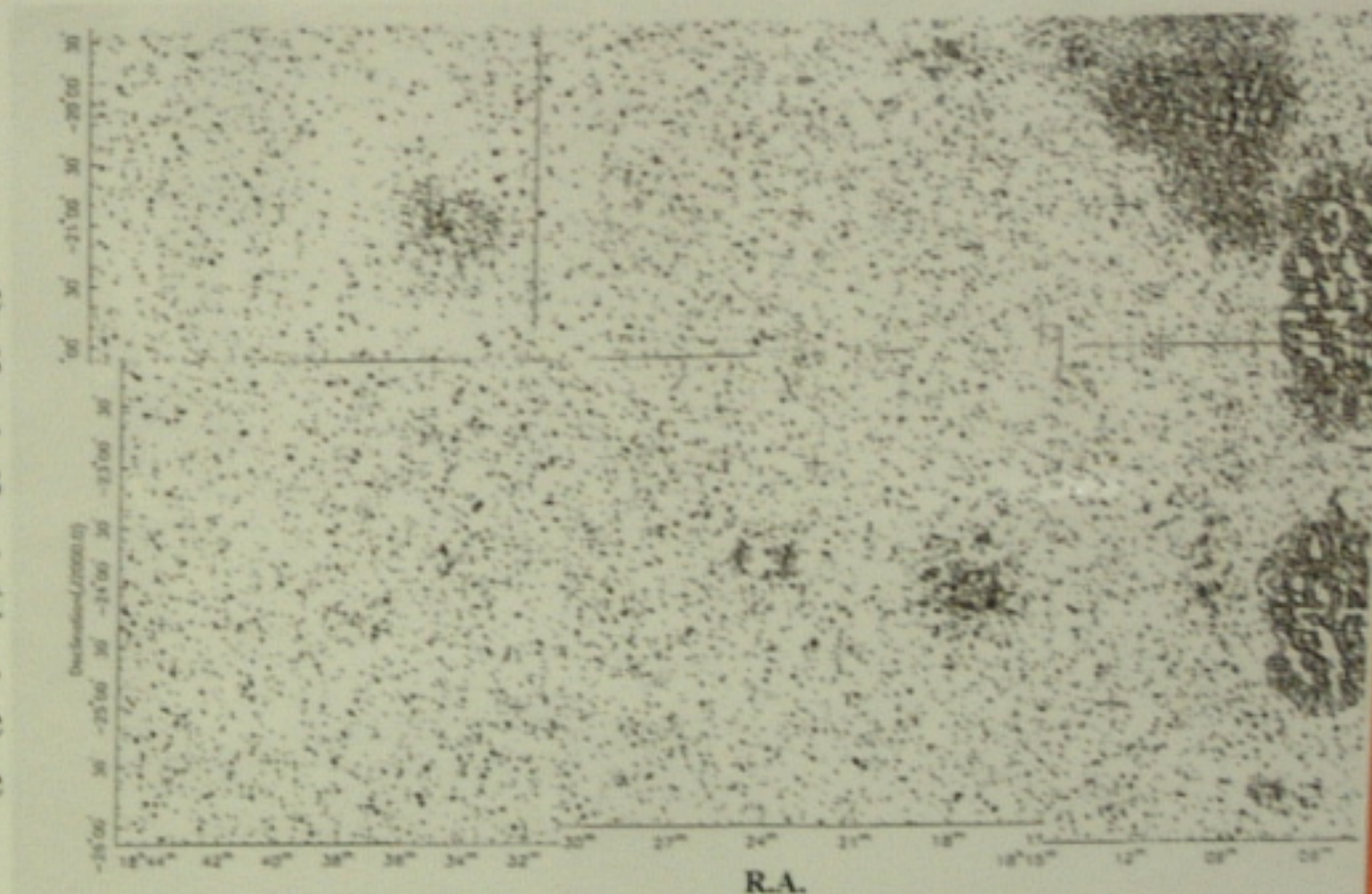
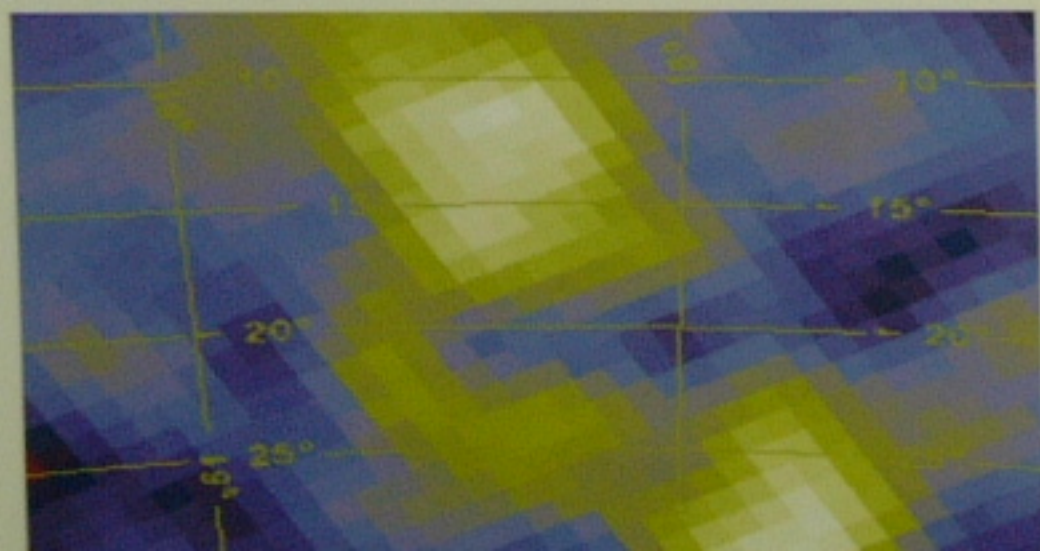


Figure 2: 1.4GHz Radio map of the SUGAR excess region (NRAO NVSS server)

We have looked for any large scale structure in the source direction with COMPTEL data and have searched for any unusual nearby objects which may have a direct association with high energy astrophysics. Figure 3 shows a large scale ($30^{\circ} \times 30^{\circ}$) COMPTEL map of the region. This image shows two strong gamma-ray sources which are in the plane of the galaxy, and symmetrical when viewed from the source position. It is possible that this suggests a large-scale shell surrounds the source and crosses the galactic plane at those two points.



There is a remarkable source at the edge of the central source region. This is SAX J1819.3-2525 (V4641 Sgr). It is a microquasar, an X-ray nova with relativistic (superluminal) radio jets in a black hole binary system at an estimated distance of 0.5 kpc. It had a strong, well documented, outburst in September 1999 (Revnivtsev et al. 2002) which reached a level of more than 10 Crabs for RXTE and has flared again recently (May/June 2002 – see: <http://vsnet.kuastro.kyoto-u.ac.jp/vsnet/Xray/v4641sgr02.html>).

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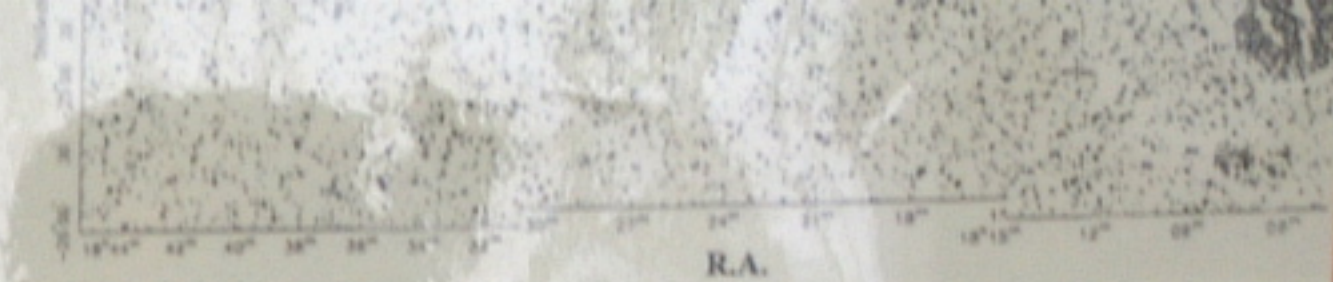


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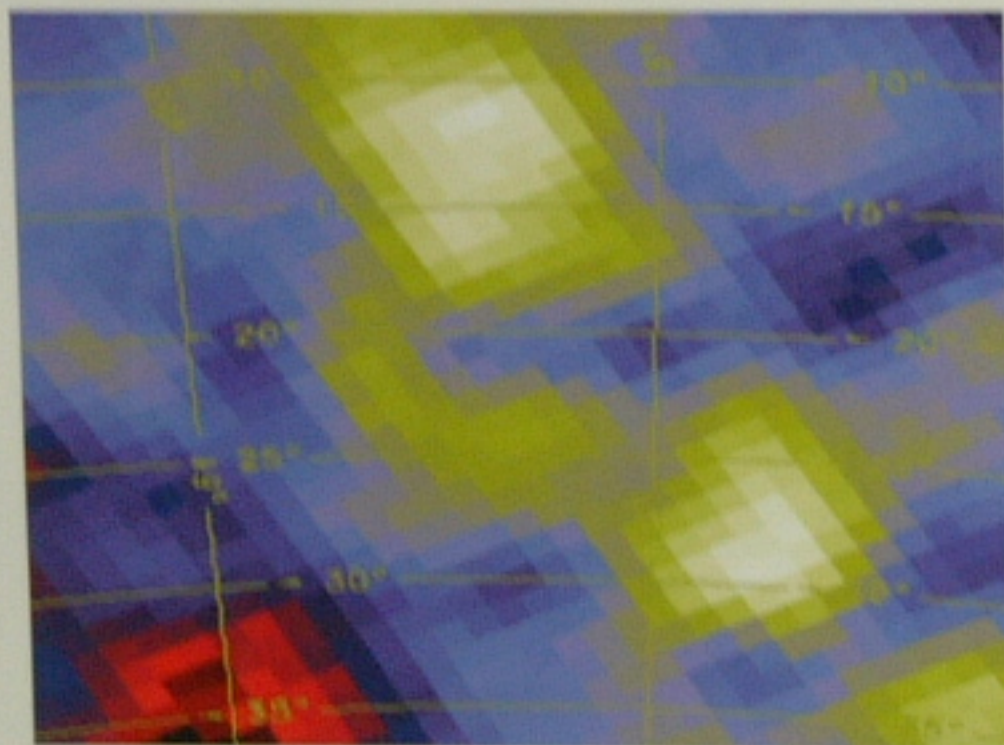


Figure 3: COMPTEL Map of the SUGAR excess region (NASA SkyView)

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In conclusion, the SUGAR source region contains a number of candidate astronomical sources for cosmic ray acceleration. Sources which may be of particular interest are a microquasar, a supernova shell, and an unusual region containing an EGRET source.

References

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